

APPENDIX I: VEGETATION

Because of the specific requirements of different plant communities, dominant vegetation types are a valuable indicator of relative precipitation, temperature, soil type, solar radiation, and altitude. Therefore, changes of vegetation types can indicate changes in the physical environment, which may affect freshwater salmon habitat. The following discussion of vegetation was compiled from studies by Franklin and Dyrness (1973), Barbour and Major (1977), and Hickman (1993).

Sitka Spruce Zone—Coastal regions in Oregon are forested with a Sitka spruce-dominated plant community: Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), and Douglas fir (*Pseudotsuga menziesii*) are major species that occur there. This vegetation type is restricted to coastal regions and river valleys and only on the coastal plains does it extend farther than a few kilometers inland. The Sitka Spruce Zone reaches elevations above 150 m (490 ft) only in areas immediately adjacent to the ocean. However, where mountains are adjacent to the coast, the zone may extend to 600 m (1970 ft). This vegetation type only occupies areas with a uniformly wet and mild climate. Sitka spruce forests could be considered a variant of western hemlock forests of higher elevations and inland areas, but they are distinguished by frequent summer fogs and proximity to the ocean (Franklin and Dyrness 1973).

Western Hemlock Zone—Along the Oregon coast, the western hemlock-dominated plant community replaces Sitka spruce at elevations above 150 m (490 ft). This zone includes western hemlock, Douglas fir, red alder, and western red cedar as major tree species. South of the Columbia River, the Western Hemlock Zone extends southward along the Coast Range to the Klamath Mountains and southward along the Cascade Mountains to the Umpqua River.

Alpine and Subalpine Zones—The headwaters of rivers draining higher mountains, such as the Cascade Mountains and Oregon Coast ranges, begin in alpine meadows and subalpine parklands, before they change to western hemlock-dominated forests below 700-1,000 m (2300-3280 ft). The higher alpine regions appear as a mosaic of meadows and tree patches with long-lasting and deep snow cover. The Subalpine Zone is dominated by mountain hemlock (*Tsuga mertensiana*) and subalpine fir (*Abies lasiocarpa* var. *lasiocarpa*) and is wetter and colder than areas at lower elevations, but has less extended snow cover than the higher alpine areas. With the exception of some of the higher peaks in the Coast Range, the majority of this zone is found in the drainage of the North Umpqua River.

Umpqua Valley—The interior Umpqua Valley area is a complex of many different vegetation types. These include coniferous tree associations including Douglas fir, Ponderosa pine (*Pinus ponderosa*) and Incense Cedar (*Calocedrus decurrens*), oak forest stands, woodlands and savannas with Oregon oak (*Quercus garryana*), California black oak (*Quercus kelloggii*) and madrone (*Arbutus menziesii*), grasslands with Kentucky bluegrass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), and Idaho bent (*Agrostis Idahoensis*), sclerophyllus hillside communities dominated by Douglas Fir, tan oak (*Lithocarpus densiflora*), canyon live oak (*Quercus chrysolepis*), madrone, chinquapin (*Chrysolepis chrysophylla*), and riparian communities with black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), many willow species (*Salix rigida*, *S.*

lasiandra, *S. fluvialis*, and *S. sessilifolia*), Oregon oak, and California laurel (*Umbellularia californica*).

Mixed Conifer and Evergreen Forest Zones—The Klamath Mountain Province (ONHP 2003) extends into the Umpqua Basin in the region of the South Umpqua and mainstem Umpqua Rivers. This section of the province is the northern Siskiyou Mountains. In the western Siskiyou Mountains, the dominant vegetation is a mixed forest of evergreen-needle-leaved trees and broad-leaved evergreen sclerophyllous trees. Dominants in these mixed evergreen forests are Douglas fir, tan oak, madrone, and chinquapin. These species are more allied with forests found to the south than those in the more mesic coastal areas.

APPENDIX II: ECOREGIONS OF THE OREGON COAST COHO SALMON ESU FROM SOUTH OF THE COLUMBIA RIVER TO CAPE BLANCO

Level 3 ecoregions are shown in Figure 15; level 4 ecoregions are shown in Figure 16. These descriptions are compiled from Thorson (2003) and ONHP 2003b.

Level 3 Ecoregion Descriptions

Klamath Mountain Ecoregion—The Klamath Mountain Ecoregion within the Oregon Coast Coho Salmon ESU is found in the Interior Umpqua River Basin, encompassing systems such as Cow Creek, South Umpqua River, and a portion of the North Umpqua River. This area is the most northerly of a system of mountains that extend into northwestern California (the Siskiyou Mountains). These are the oldest landscapes in Oregon, due to their origin as ocean crust or island archipelago environments that were carried eastward on a tectonic plate that collided with the continent of North America. These terranes (exotic pieces of landscapes) were then welded to the continent by granitic intrusives (Orr and Orr 2000). This area is a very diverse geological landscape, which includes serpentine, limestone, and gabbro, as well as granite and basalt. The Umpqua portion of the Klamath Mountains Ecoregion is less rugged than others found in the Rogue Basin just to the south. Precipitation in this portion of the ecoregion tends to be drier than the more coastal portions of the Klamath Mountains and summer high temperatures can average more than 32°C (90°F). Vegetation is diverse in this area and is described in the level 4 ecoregion descriptions for the Siskiyou foothills, Umpqua Interior foothills, and Coastal Siskiyou.

Oregon Coast Range Ecoregion—The entire coast of Oregon is included within the Oregon Coast Range Ecoregion, and extends eastward to include the northern and central Oregon Coast Range Mountains. Geology is a mix of sedimentary sandstones, siltstones, and mudstones, with areas of volcanic activity. Elevations range from sea level to 1200 m (4,000 ft). The marine climate moderates temperatures, which average 10°C (50°F). Average annual rainfall may vary from 152 to 460 cm (60 to 180 in.) per year. The soils in this region are generally deep and mature and vegetation is dominated by giant Sitka spruce, Douglas fir and western hemlock forests. In the southern end of the range, Coast redwood, Port Orford cedar, red alder, and tan oak also become co-dominants.

West Cascade Ecoregion—The West Cascades Ecoregion within the Oregon Coast Coho Salmon ESU is found in the Umpqua Basin, specifically in the North Umpqua and South Umpqua drainages). Geology is closely related to volcanic activity of the Cascade Crest. The ecoregion is dominated by Douglas fir-western hemlock forests to about 1,000 m (3,300 ft). Above that, silver fir/mountain hemlock forests dominate. Very little of the area within the Oregon Coast Coho Salmon ESU is alpine area. This drier portion of the West Cascades Ecoregion is subject to lightning-caused fire regimes similar to the Klamath Mountains. Snows are not as heavy as in the northern portion of the West Cascades Ecoregion in Oregon.

Level 4 Ecoregion Descriptions

Descriptions below refer to areas mapped in Figure 16.

Coastal Lowlands – elevations sea level to 90 m (300 ft)—Estuaries within the Oregon Coast Coho Salmon ESU are all drowned river mouths. (Good 2000). They are mainly of three types: well-flushed drowned rivers, seasonally open to the ocean (such as Sixes, New River); well-flushed drowned rivers, predominantly freshwater input (e.g., Coquille, Umpqua, Siuslaw); and well-flushed drowned rivers with predominantly oceanic input (such as Coos, Sand Lake, Yaquina, Nestucca). Many of these areas historically had relatively large areas of salt, brackish, and freshwater marshes; sloughs; and swamps. Most, however have suffered losses of these areas of up to 80% of these tidally-influenced systems through diking and channelization.

Sand dune sheets are part of the Pacific Northwest Coastal Region (Terrel 1979, Proctor et al. 1980) between the Strait of Juan de Fuca in Washington State to Cape Mendocino in California. Two hundred and twenty-five kilometers of the Oregon Coast is covered by these dune systems. Some are found as isolated areas associated with bays and river mouths between headlands (such as Netarts Bay). Others are extensive dune sheets found on broad terraces (such as Coos Bay Dune Sheet and Sand Lake). These broad terraces may have extensive dune systems and may also harbor extensive freshwater lakes, bogs, fens, and blackwater streams (Wiedemann 1984, ONHP 2003b).

Coastal Uplands– elevations to about 150 meters (500 ft)—This ecoregion is characterized by uplifted marine consolidated and semi-consolidated sediments. These include sandstones and siltstones. Also included are some volcanics.

Volcanics—Volcanic geology is found at elevations from 300 to 1200 m (1,000 to 4,000 ft). These volcanics are of various origins: these include the Columbia River Basalts, the Siletz River, and the Yachats series of basalts. Some of the mountains found in this ecoregion may have been off-shore seamounts buried by continental sediments (ONHP 2003b, KCM 1983)

Willapa Hills—These low-lying hills are a continuation of a larger area north of the Columbia River (WDNR 2003). These are in the Western Hemlock Zone.

Mid-Coastal Sedimentary—The Mid-Coastal Sedimentary Ecoregion is underlain by siltstone and sandstone. The mountains are more rugged (dissected and higher) than the Willapa Hills. These sedimentary mountains are very prone to landslides if the vegetation is removed. Stream gradients and fluvial erosion rates can be high in these rugged areas, but are lower in the higher order streams that occupy the lowlands. Many of these areas have deep soils, and most are in the Western Hemlock Zone (ONHP 2003b).

Southern Oregon Coastal Mountains—These are mountainous areas in the south portion of the Oregon Coast Coho Salmon ESU with ocean-modified climate. They are transitional between the Siskiyou and Coast ranges. These areas are underlain by Jurassic sandstone, metamorphosed sediments, granite, and serpentine (metamorphosed ocean sediments). Soils are dependent upon parent material. This is a complex much like the Inland Siskiyou, but the ruggedness is less and elevations are lower. This is an area of very high plant diversity. The northern distribution

limits of southern plant and animal species and southern limit of northern plant species are one reason for the diversity. Also, the area's unusual geology and stable climate have led to the evolution of local endemic plants. The Mixed Conifer and Evergreen Zones are found in this subregion (Orr and Orr 2000, Barbour and Major 1977, ONHP 2003b).

Inland Siskiyou—This area encompasses the Umpqua and Rogue valleys and is very complex vegetationally. These vegetation types include Douglas fir forests, oak woodlands and savanna, mixed evergreen forest, mixed conifer forests, and Ponderosa pine woodlands. Grasslands and chaparral are found in the valley bottoms. Geology is complex with large areas of metamorphosed rocks such as serpentine and gabbro, sedimentary rocks such as limestone, as well as granite and basalt. Floristic elements of the Sierra Nevada Mountains, Sacramento Valley, Cascade Mountains, and Great Basin are all found in this ecoregion and contribute to the high plant diversity found here. Because of its unusual geology, and stable climate, it is also a major locality of vascular plant species evolution as well. Conifers are especially diverse in the Oregon section of the Inland Siskiyou subregion with 18 species. This area has major climatic extremes ranging from 254 cm (100 in.) of precipitation per year to 50 cm (20 in.) (Orr and Orr 2000, Barbour and Major 1977, ONHP 2003b).

Valley Foothills—This subregion is an extension of the Willamette Valley on the west side, and is transitional between the Cascade Mountains and the Coast Range. This area has lower rainfall than adjacent mountainous subregions due to a rainshadow effect. Oregon white oak and Douglas fir are potentially dominant in this area, but agricultural conversion has substantially reduced the native forests (ONHP 2003b).

Umpqua Interior Foothills—This is an area of narrow interior valleys, terraces, and foothills with elevations from about 120 to 460 m (400 to 1500 ft). Vegetation is a mix of Oregon white oak woodlands and coniferous forests with pastureland, vineyards, row crops, and orchards replacing the native vegetation. Other dominant tree species found are Douglas fir, Ponderosa pine, and madrone (ONHP 2003b).

Umpqua Cascades—This portion of the Cascades is dryer than the western Cascades. Grand fir, white fir, western hemlock, Pacific silver fir, Douglas fir, and Shasta red fir dominate. The diversity of vegetation is greater than the western Cascades subregions due to warmer summer temperatures and a longer growing season, as well as floristic elements from both northern and southern floristic provinces (ONHP 2003b).

APPENDIX III: POTENTIAL HISTORICAL ABUNDANCE OF COHO SALMON

Having estimates of potential historical abundance of coho salmon populations is useful for a number of reasons. Such estimates can be used to compare with current abundance, they could be useful for developing an understanding of limiting factors, and they can be used in modeling the independence of individual populations. Here we use two independent approaches to estimate historical abundance of coho salmon in the Oregon Coast Coho Salmon ESU for the purpose of modeling the independence of individual populations.

Calculating Adult Abundance from Catch

Lichatowich (1989) estimated historical abundance of adult coho salmon based on in-river catch records. Mullen (1981a) compiled catch records for individual coastal basins within the Oregon Coast Coho Salmon ESU and converted pounds landed to estimated number of adult salmon. Both Mullen (1981b) and Lichatowich (1989) divided total number of fish landed coast-wide by an assumed exploitation rate of 40% to estimate total abundance. Mullen (1981b) estimated mean annual abundance for 5-year intervals from 1892 to 1940. Lichatowich (1989) estimated mean annual abundance for the five peak years between 1892 and 1920, which he considered a conservative measure of production because of the many problems associated with the accuracy of the early cannery records.

The methods of Mullen (1981b) and Lichatowich (1989) were adopted here with the exception that they were applied to the peak year of catch in each of 10 coastal basins during the period of 1882-1925 as estimated by Mullen (1981a). Because maximum catch of coho salmon in individual basins did not occur in a single year, this approach gives a better estimate of potential historical abundance. Peak catches in the 10 basins actually occurred in six different years. However, like the earlier estimates, these estimates of abundance only apply to streams where fisheries took place. The 10 basins included represent about 89% of the coho salmon distribution in the Oregon Coast Coho Salmon ESU.

Calculating Adult Abundance from GIS Data

Data from CLAMS used to calculate intrinsic potential for coho salmon (Burnett et al. 2003) (Figs. III-2 through III-5) were converted to an estimate of historical potential smolt abundance for each population in the Oregon Coast Coho Salmon ESU. The estimated smolt potential was then converted to adult potential by applying a marine survival rate.

Stream reaches were divided into two categories based on their gradient. Those reaches with a gradient less than or equal to 0.5% were assumed to be associated with wetlands and an expansive floodplain (Rosgen 1994, 1996; Buffington et al. 2002; Montgomery and Buffington 1997), which would provide winter habitat for coho salmon outside the active channel. For reaches with a gradient greater than 0.5%, the assumption was made that coho salmon smolts were produced primarily within the active channel.

For each population, potential smolt production was calculated as the sum of the potential of all reaches with intrinsic potential greater than 0. For each reach with a gradient less than or equal to 0.5%, potential smolt production was calculated from the equation

$$S = 0.0741 L (V - W) P$$

where S is the potential number of smolts produced in the reach, L is the length of the reach (m), V is the valley width (m), W is the active channel width (m), P is the intrinsic potential of the reach (an index without units), and 0.0741 is the number of smolts per square meter (741/ha) based on data from NMFS et al. (1983).

Potential smolt production was calculated for each reach with a gradient greater than 0.5% from the equation

$$S = (0.3405) (0.5) L W P$$

where 0.3405 is the number of smolts per square meter in main channel pools based on data from Nickelson (1998), and 0.5 is the proportion of the area in pools based on an assumed 50:50 pool:riffle ratio.

For lake populations, potential smolt production was estimated by multiplying the lake area by 741 smolts/ha. This is a deviation from the approach used in Washington (NMFS 1983), where only a 30-m- (100-ft-) wide littoral zone is considered. However, Oregon coastal lakes are shallow, with littoral zones that cover most if not all of their area.

Potential historical adult abundance was estimated for each population by applying a 10% marine survival rate to the smolt estimates. These estimates were capped for two stream populations and several lake populations at 1,500 adults per mile of spawning habitat based on current estimates of the miles of stream in each basin that would be available for spawning. The value of 1,500 adults per mile is consistent with the maximum level observed in a lake system tributary in 2001, a high-survival year (ODFW 2003e), and the density of coho observed in Tenmile Lakes in the 1955 (Morgan and Henry 1959) before warmwater fish became a problem.

Results

The results of the two different approaches used to estimate potential historical abundance of coho salmon in the large basins of the Oregon Coast Coho Salmon ESU produced surprisingly similar results (Table III-1). Differences between the two estimates ranged from 1% for the Yaquina Basin to 73% for the Umpqua Basin. There is a strong correlation between the estimates derived by the two methods (Figure III-1).

The advantage of calculating adult abundance from computed intrinsic potential is that estimates can be made for basins where there are no historical fishery data. Table III-2 lists the estimated potential historical abundance of coho salmon for 67 putative populations of coho salmon in the Oregon Coast Coho Salmon ESU. Total adult abundance derived from smolt numbers and 10% marine survival was about 3.5 million adults if all populations peaked the same year.

Discussion

Historical abundance of coho salmon was estimated for the purpose of modeling the effects of relative abundance on population independence. For this exercise, marine survival was assumed to be 10% for all populations. This assumption results in an unrealistically high total abundance for the Oregon Coast Coho Salmon ESU when all populations are aggregated. This aggregate estimate of 3.3 million adult coho salmon is higher than the 978,000 for the peak 5-year of Mullen (1981b) and the 1,385,000 (1,915,000 if you use the peak year) of Lichatowich (1989), both of which also included the Rogue River in the Southern Oregon Northern California ESU. The primary reasons for this result is that the populations are asynchronous; in other words, the peak abundance of the various populations did not occur in the same year as was assumed for this analysis. Thus it is a mistake to conclude that historical abundance was 3.3 million adult coho salmon. One example of an approach to use this information to come up with a more realistic ESU abundance estimate is to assume that only 60% of the coastal habitat was productive at any given time (Reeves 2003). This would yield an estimate of 2.0 million fish, which may be on the low side because most fish are produced from the lowlands, which were likely more stable than the uplands where the Reeves (2003) analysis applies. More work is needed to convert the smolt capacity estimates generated here into estimates of historical adult abundance.

It is interesting to note that the basins with the greatest discrepancy between peak adult abundance estimated from catch and that estimated from intrinsic potential are the basins with the greatest effects from splash damming at the turn of the 20th century (Sedell and Duvall 1985). In each case, the abundance of adults estimated from intrinsic potential was at least 30% greater than that estimated from catch. Thus, it could be that even as early as 1900, coho salmon populations had been significantly reduced by habitat destruction in some basins which would result in underestimates of abundance derived from harvest data.

Table III-1. Estimate of potential historical abundance of coho salmon in large basins of the Oregon Coast Coho Salmon ESU using methods based on peak historical catch and based on estimated habitat capacity (based on data from Lichatowich 1989, Chapman 1986, Burnett 2003).

Basin	Estimated Potential Historical Abundance			
	Based on catch (a)	Based on IP (b)	Difference	(b-a)/a
Nehalem	240,000	333,000	93,000	39%
Tillamook	292,500	329,000	36,500	12%
Nestucca	115,000	104,000	-11,000	-10%
Siletz	125,000	122,000	-3,000	-2%
Yaquina	120,000	122,000	2,000	2%
Alsea	150,000	163,000	13,000	9%
Siuslaw	292,500	267,000	-25,500	-9%
Umpqua	585,000	820,000	235,000	40%
Coos	150,000	206,000	56,000	37%
Coquille	310,000	417,000	107,000	35%

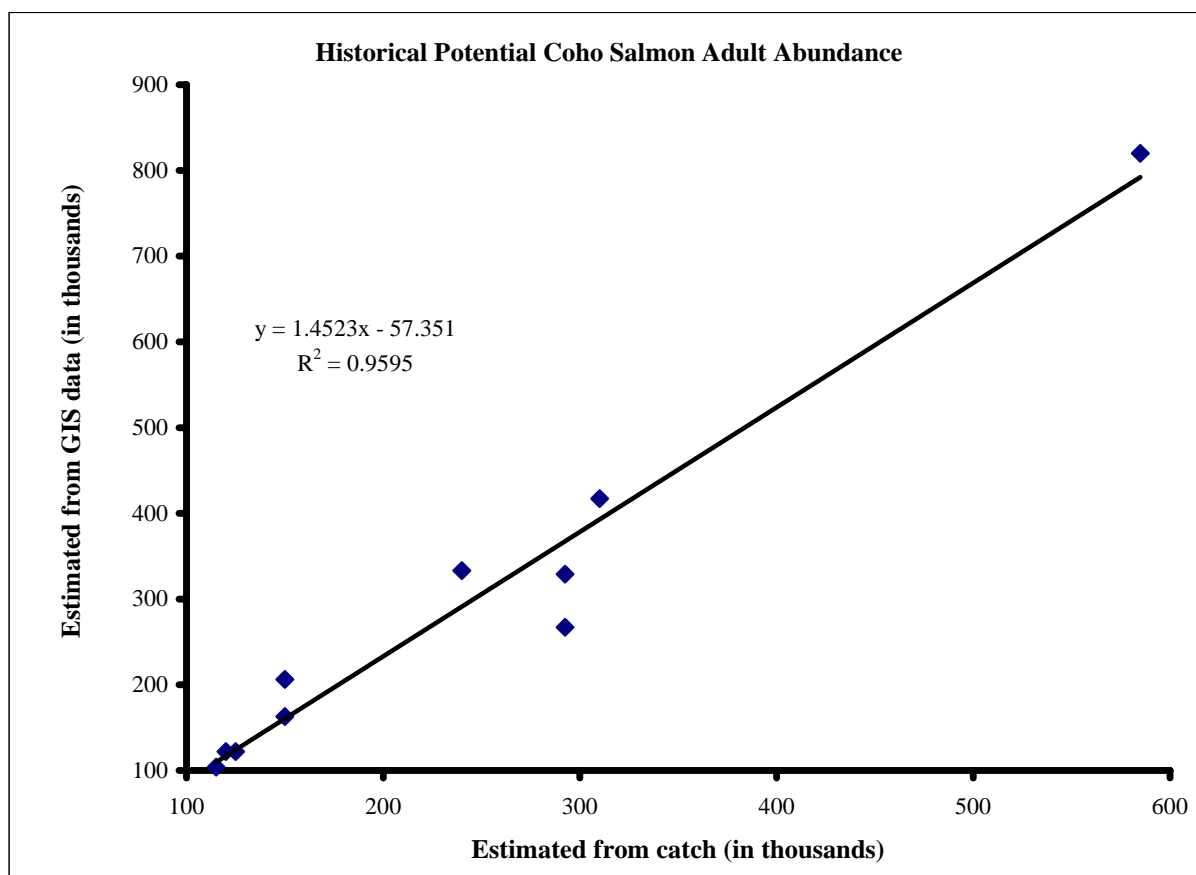


Figure III-1 The relationship between historical potential coho salmon adult abundance estimated by historical catch records and adult abundance calculated from GIS data (data from Table III-1).

Table III-2. Potential historical smolt and adult abundance for 67 putative populations of coho salmon in the Oregon Coast Coho Salmon ESU (based on data from Burnett 2003, NMFS 1983).

Population	Potential smolts	Adults @ 10% marine survival	Population	Potential smolts	Adults @ 10% marine survival
Necanicum R.	685,000	69,000	Moore Cr.	1,000	100
Indian Cr.	100	10	Theil Cr.	20,000	2,000
Canyon Cr.	400	40	Beaver Cr.	265,000	27,000
Ecola Cr.	72,000	7,000	Alsea R.	1,628,000	163,000
Red Rock Cr.	100	10	Little Cr.	1,000	100
Austin Cr.	300	30	Big Cr.	34,000	3,000
Asbury Cr.	1,000	100	Vingie Cr.	3,000	300
Arch Cape Cr.	3,000	300	Yachats R.	110,000	11,000
Short Sand Cr.	4,000	400	Gwynn Cr.	1,000	100
Nehalem R.	3,330,000	333,000	Cummins Cr	10,000	1,000
Spring Cr.	5,000	500	Bob Cr.	6,000	600
Watseco Cr.	5,000	500	Tenmile Cr.	28,000	3,000
Tillamook Bay	3,288,000	329,000	Squaw Cr.	100	10
Netarts Bay	15,000	1,500	Rock Cr.	6,000	600
Rover Cr.	2,000	200	Big Cr.	18,000	2,000
Sand Cr.	123,000	12,000	China Cr.	5,000	500
Nestucca R.	1,037,000	104,000	Blowout Cr.	1,000	100
Neskowin Cr.	49,000	5,000	Cape Cr.	15,000	2,000
Salmon R.	168,000	17,000	Berry Cr.	54,000	5,000
Devils Lake	85,500	9,000	Sutton Cr.	84,000	8,000
Siletz R.	1,217,000	122,000	Siuslaw R.	2,674,000	267,000
Schoolhouse Cr.	2,000	200	Siltcoos R.	771,000	77,000
Fogarty Cr.	18,000	2,000	Tahkenitch Cr.	228,000	23,000
Depoe Bay Cr.	7,000	700	Threemile Cr.	22,000	2,000
Rocky Cr.	10,000	1,000	Umpqua	8,199,000	820,000
Johnson Cr.	2,000	200	Lower Umpqua	1,293,000	129,000
Spencer Cr.	11,000	1,000	Upper Umpqua	6,906,000	691,000
Wade Cr.	5,000	500	Tenmile Cr.	525,000	53,000
Coal Cr.	4,000	400	Coos Bay	2,058,000	206,000
Moolack Cr.	4,000	400	Coquille R.	4,169,000	417,000
Big Cr.	26,000	3,000	Johnson Cr.	8,000	800
Yaquina R.	1,217,000	122,000	Twomile Cr.	134,000	13,000
Henderson Cr.	1,000	100	Floras Cr.	396,000	40,000
Grant Cr.	400	40	Sixes R.	372,000	37,000

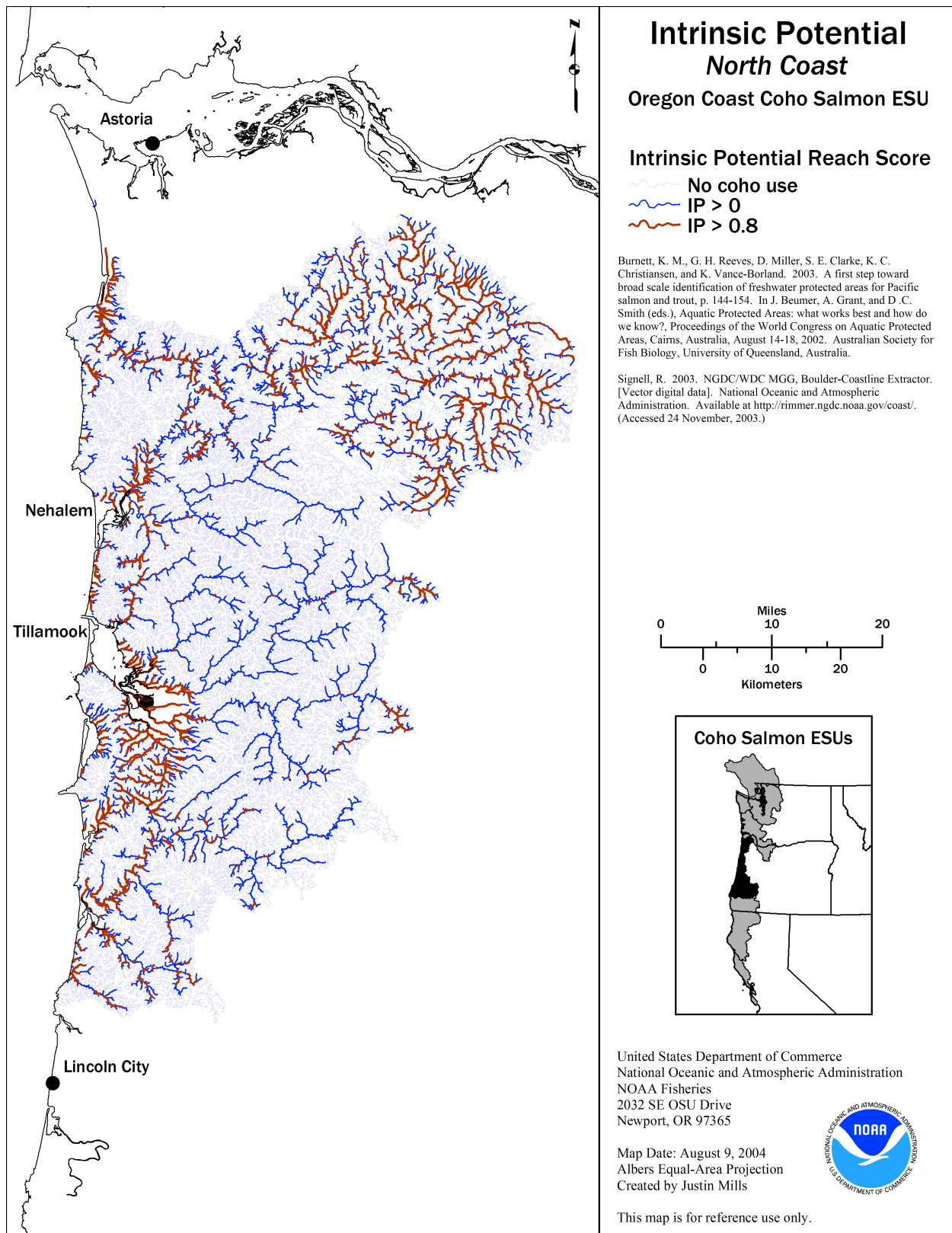


Figure III-2. Intrinsic Potential of rivers and streams on the North Coast segment of the Oregon Coast Coho Salmon ESU.

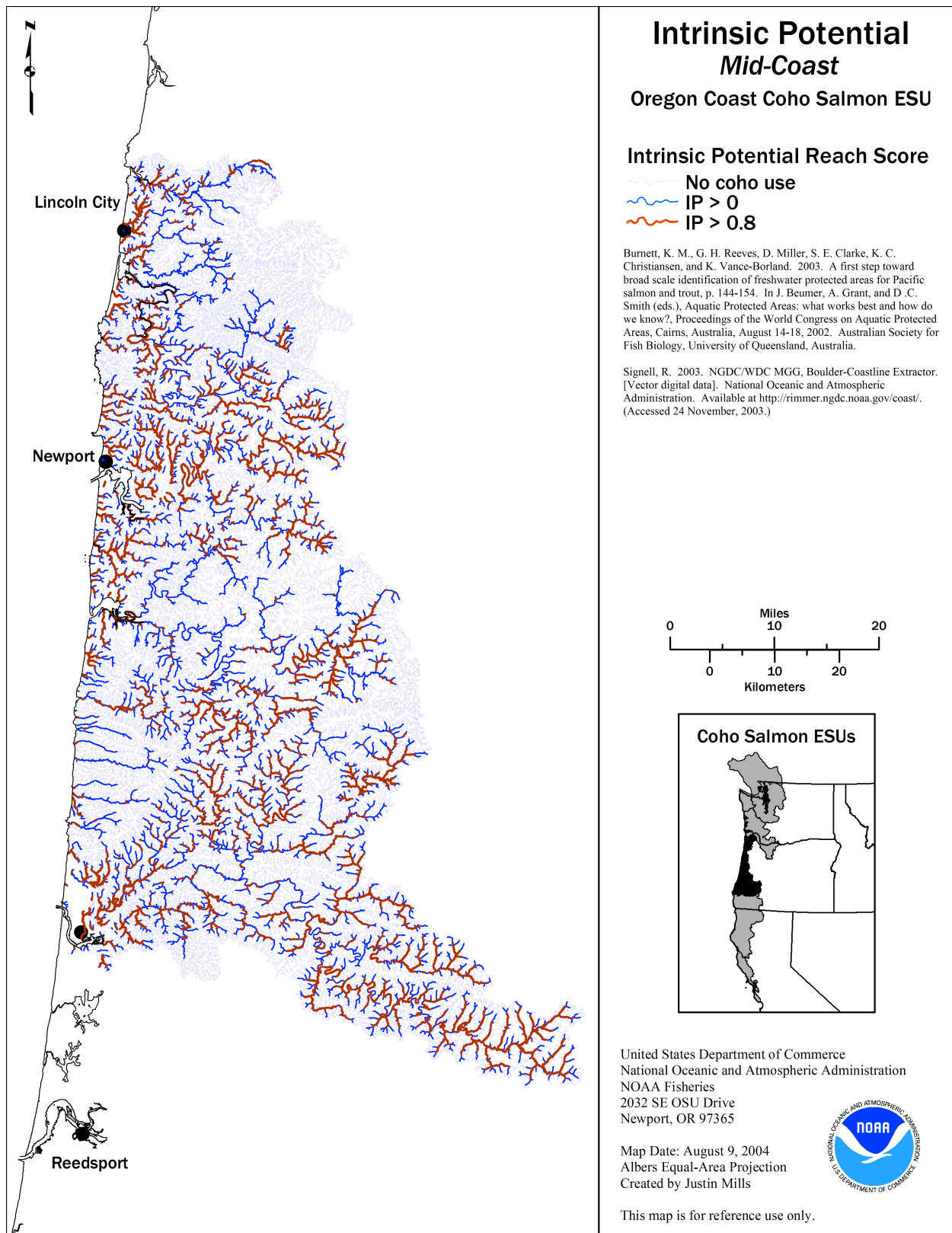


Figure III-3. Intrinsic Potential of rivers and streams on the Mid-Coast segment of the Oregon Coast Coho Salmon ESU.

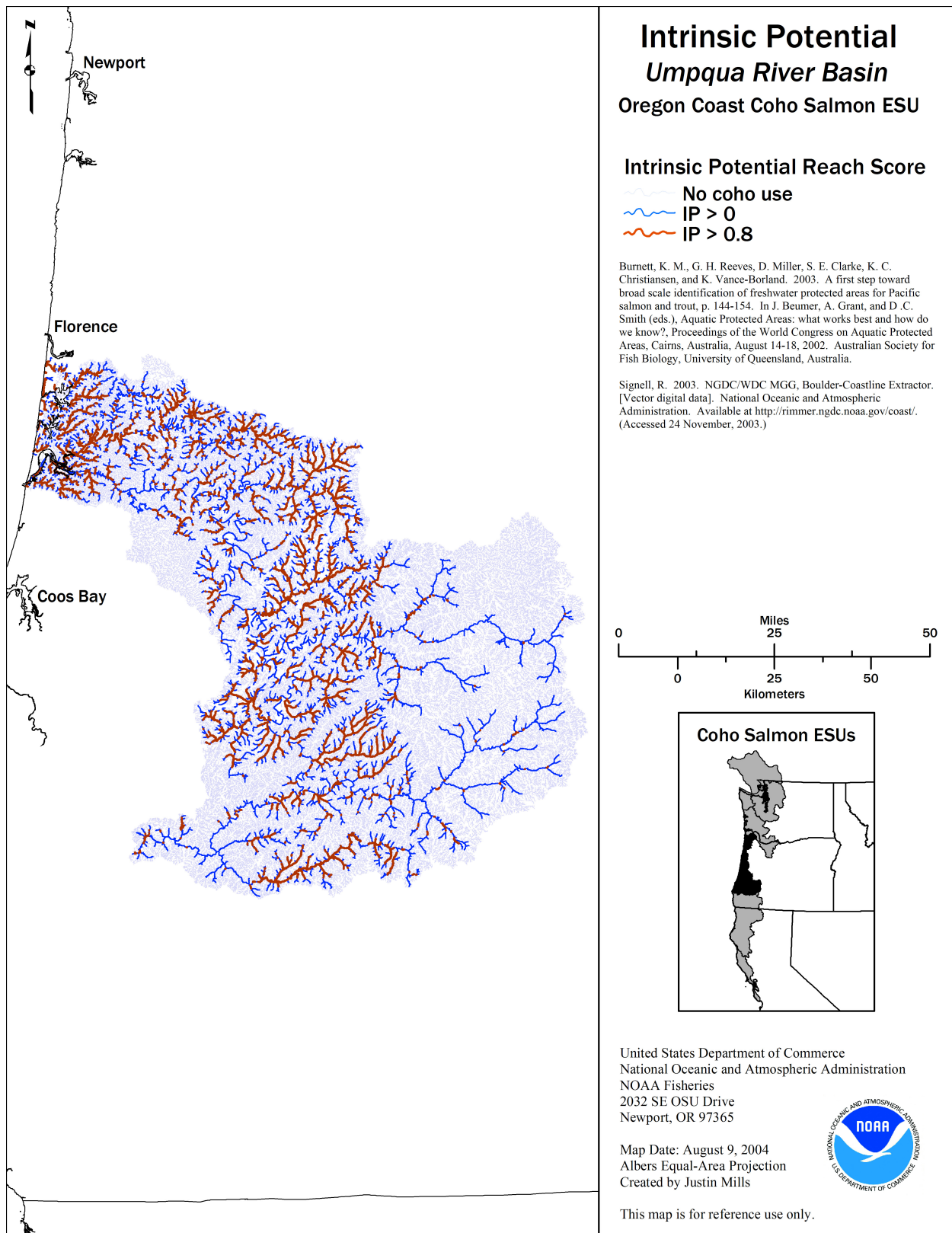


Figure III-4. Intrinsic Potential of rivers and streams on the Umpqua River Basin segment of the Oregon Coast Coho Salmon ESU.

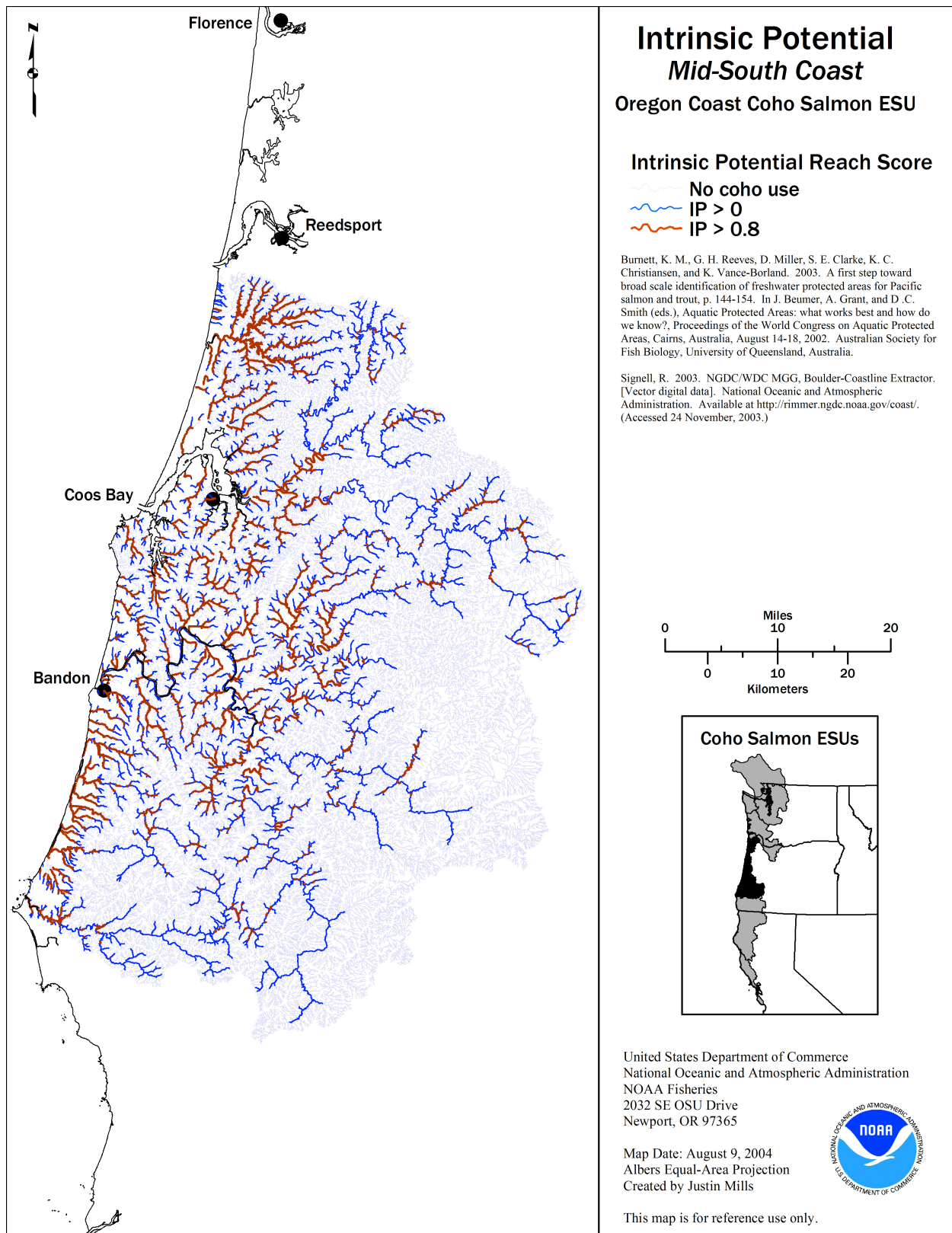


Figure III-5. Intrinsic Potential of rivers and streams on the Mid-South Coast segment of the Oregon Coast Coho Salmon ESU.

